May 31, 1966 K. F. ELLIOTT 3,254,174

MAGNETICALLY CONTROLLED ROTARY SWITCH

Filed Nov. 8, 1963 2 Sheets-Sheet 1

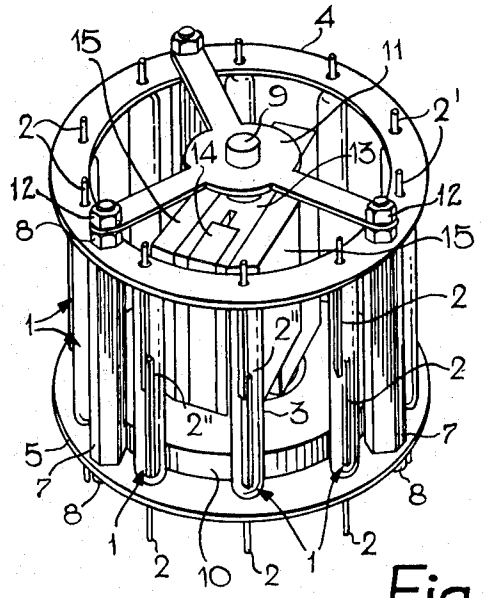
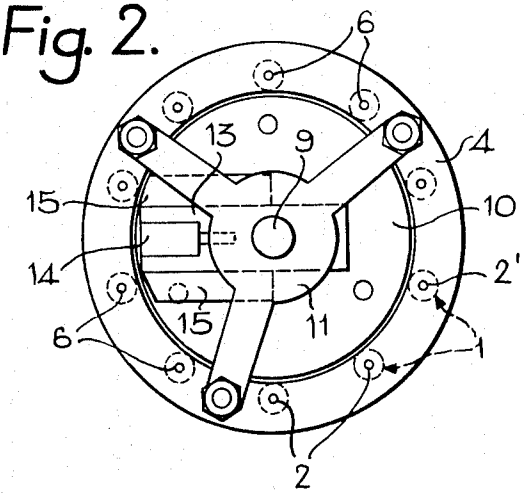


Fig. 1.

Fig. 2.



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MAGNETICALLY CONTROLLED ROTARY SWITCH

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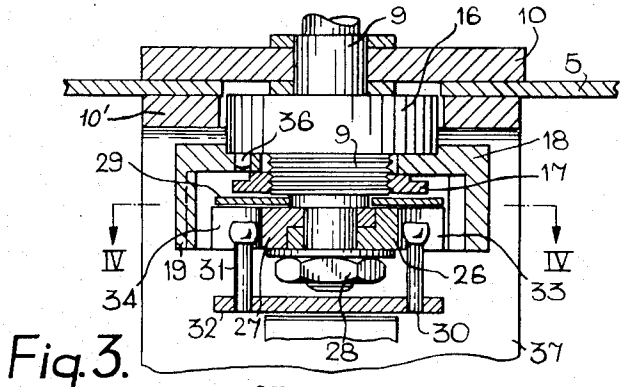


Fig. 3.

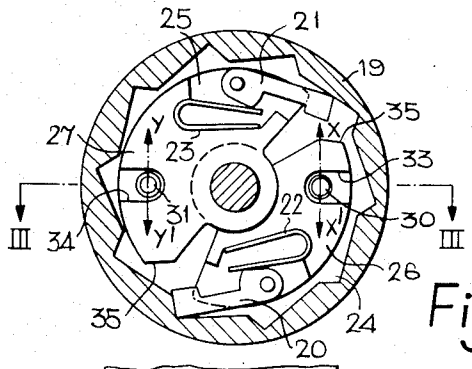


Fig. 4.

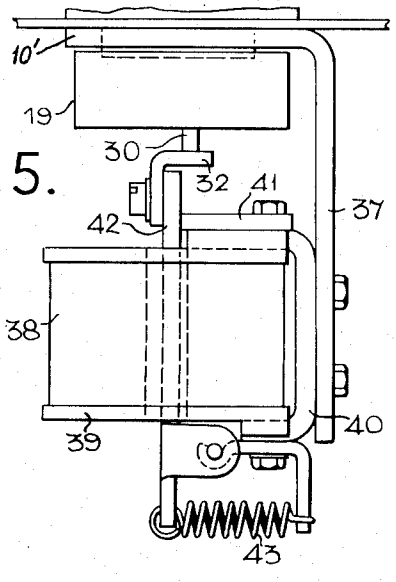


Fig. 5.

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MAGNETICALLY CONTROLLED ROTARY SWITCH

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Multiple position rotary switches which permit selective establishment of different connections through them according to the switch position are known in various forms which comprise in general a plurality of circumferentially distributed fixed contacts and at least one rotatable moving contact or wiper by which the fixed contacts can be selectively engaged. Such switches are subjected to considerable wear and tear in use, especially when they have a high rate of usage, and it is also difficult to ensure a consistent quality of the connection afforded through the engaged fixed and moving contacts, a factor which can be of particular importance in switching light currents, for instance in using such switches for telephone switching or for scanning or surveying a group of light-current devices. There is also the necessity of providing some means affording interconnection between the rotatable moving contact and a static external connection.

According to one aspect of the present invention there is provided an improved form of multi-position rotary switch which uses switching units of the reed contact kind in which, as is well known, at least two magnetic reed contact elements extend towards each other into overlapping relationship, usually within a sealed enclosure, so that when subjected to a longitudinal magnetic field their overlapping ends will be actuated towards each other by mutual attraction to establish electrical contact therebetween. The other ends of the contact elements, projecting out of the usual enclosure at opposite ends thereof, can serve as mounting and wiring tags for the contact unit.

According to this aspect of the invention the multi-position rotary switch comprises at least one bank of such reed contact units arranged like bars of a cage around a central rotatable spindle with a permanent magnet switching assembly mounted thereon providing at a position offset from the spindle axis a magnetic field which by rotation of the spindle can be brought into proximity with the several switching units of said bank in turn, this field having its magnetic axis so orientated as to actuate the reed contact unit in whose proximity it is at any instant, said switching assembly being provided with flux controlling side members for limiting sideways spread of the magnetic flux, thereby increasing the selectivity of operation.

The contact units can be connected separately into independent circuits. Alternatively, by providing a common connection to which one contact element of each switching unit is connected, the switch can be arranged to act in the manner of a rotary switch having a common wiper engaging a bank of fixed contacts. The magnetic field may be arranged to actuate two adjacent units, for instance by positioning such two units sufficiently close to each other. It would also be possible to provide one or more additional banks of reed contact switching units similarly arranged around the spindle for actuation by the

magnetic field of the same or another switching assembly provided on it. With the magnetic field stationary in the proximity of a switching unit the contact elements of this unit will be actuated and will remain actuated without requiring any additional holding provision.

The spindle is preferably associated with some form of mechanism which imposes a stepping or notching action on its rotation so that the different positions of the switch are positively determined: the angular locations of the contact units round the spindle would in such case be appropriately related to the defined switching positions.

According to another aspect of the invention, to effect such stepwise rotation of a rotary switch, whether manually or otherwise, a ratchet wheel and pawl driving mechanism is provided which has a particularly compact form and produces relatively large stepping movements from successive actuations of a primary actuating member. This mechanism comprises an internally toothed ratchet wheel co-operating with two pawls which act on the ratchet wheel in the same rotational sense and are carried at substantially diametrically opposed locations by respective members which are mounted for angular oscillation about a central axis and are coupled to a reciprocable actuating member effective on each stroke in one sense to cause angular movements of the pawl-carrying members in opposite rotational directions and on each stroke in the opposite sense to cause reverse angular movements of these members, the two pawls thereby acting alternately in driving the ratchet wheel. To effect the rotation of the spindle of the switch in response to stepping electrical pulses the driving mechanism, and in particular the reciprocable actuating member of the mechanism just described, may be arranged for electromagnetic actuation.

In order that the nature of the invention may be more fully understood reference will now be made to the accompanying drawings in which:

FIG. 1 is a pictorial view partly broken away of a multi-position rotary switch conforming to the invention,

FIG. 2 is a plan view of FIG. 1,

FIG. 3 is a view in sectional elevation on the line III—III in FIG. 4 of a form of stepping mechanism which may be used for stepping round the switch of FIG. 1,

FIG. 4 is a sectional plan view on the line IV—IV in FIG. 3, and

FIG. 5 is a view in elevation of an arrangement for electromagnetically actuating the stepping mechanism of FIGS. 3 and 4.

Referring to FIGS. 1 and 2 a number of reed contact switching units **1**, each comprising magnetic reed contact elements **2** extending into a sealed enclosure **3** from opposite ends, are arranged in a circle, cagewise, between two insulating locating rings **4** and **5** formed with holes **6** through which pass the projecting ends **2'** of the reed contact elements, which thereby locate the units **1** in position. The rings **4** and **5** are supported and held in position by spacing pillars **7** on to which retaining nuts **8** are screwed at each end. A rotatable spindle **9** is centrally located by means of bearing members **10** and **11**, of which **10** is a bearing plate secured to the ring **5** by screws (not shown) and **11** is a bearing spider secured to the extremities of the pillars **7** by means of nuts **12**. Spindle **9** carries a permanent magnet switching assembly comprising a radially extending block **13** in the end of which is fixed a permanent magnet **14** with its magnetic axis extending parallel to the spindle axis. Soft iron pieces **15**

secured on opposite sides of the block **13** limit the spread of the flux from the magnet **14**. By rotation of the spindle **9** the magnet **14** can be brought into proximity with any selected switching unit **1**, the reed contact elements **2** of which will consequently have induced in them a longitudinal magnetic flux by which the overlapping ends **2''** of these elements are attracted into contact in well known manner.

To achieve stepwise rotation of the spindle **9** the arrangement illustrated in FIGS. 3 and 4 can be used. FIG. 3 shows from FIG. 1 the end of the spindle **9**, its bearing plate **10** and a fragment of the locating ring **5**. The ring **5** is shown sandwiched between the bearing plate **10** and a mounting plate **10'**, these two plates being screwed together by the screws already mentioned for securing the ring **5** to the plate **10**. Between a flange **16** on the spindle **9** and a ring nut **17** secured on an enlarged threaded portion **9'** of the spindle **9** is clamped an inwardly extending flange **18** of an internally toothed ratchet wheel **19** (see also FIG. 4). The teeth of the ratchet wheel **19** are engaged at approximately diametrically opposed positions by two pawls **20** and **21** which together with respective return springs **22** and **23** are mounted in recesses **24** and **25** in respective segmental members **26** and **27**. These members **26** and **27**, which together cover an angle less than 360° by a number of degrees somewhat more than the angular pitch of the ratchet teeth, are mounted on the spindle **9** so as to be free for angular movement on it, being held in place by a nut **28** with an annular plate **29** covering the recessed pawls and their springs: the bearing apertures through which the spindle **9** passes in the members **26** and **27** are formed in complementary recessed portions of these members in order that their upper and lower surfaces will lie in the same planes. The heads of round headed pins **30** and **31** carried by an actuating member **32** are freely received by the members **26** and **27** in U-shaped notches **33** and **34**. The actuating member **32** is reciprocable perpendicularly to the plane of FIG. 3 so that the pins **30** and **31** can be moved to and fro along the lines XX' and YY' in FIG. 4. Movement towards X' and Y' produces a clockwise movement of the member **26** which causes its pawl **20** to drive the ratchet wheel **19** in the same (clockwise) direction and also produces an anti-clockwise movement of the member **27** which causes its pawl **21** to ride over one ratchet tooth and act as a detent. Subsequent movement towards X and Y produces a clockwise movement of the member **27** so that its pawl **21** now acts as a driving pawl producing further rotation of the wheel **19**, again clockwise, and also produces anti-clockwise movement of the member **26** so that this time its pawl **21** rides over a ratchet tooth and acts as a detent. Overriding of the ratchet wheel teeth is prevented by engagement of the driving pawl **20** or **21** of a sloping face **35** on the alternate member **27** or **26**. Proper angular location of the ratchet wheel **19** on the spindle **9** in order to establish proper relationship of the magnet **14** with respect to the switching unit **1** in the various positions of the switch can be ensured by means of a locating pin **36**.

For actuating the mechanism electromagnetically an arrangement such as that illustrated by FIG. 5 may be used. Here the mounting plate **10'** of FIG. 3 is shown as forming part of a bracket **37** which also carries an electromagnet assembly. This latter consists of a coil **38** on a hollow bobbin **39** secured to the bracket **37** by means of a U-shaped bracket **40** which also serves as a flux return path and carries a pole-piece **41**. A pivoted armature **42** extending through the bobbin **39** and having a return spring **43** co-operates with the pole-piece **41** and carries the actuating member **32** (FIG. 3) with its pins **30–31** in engagement with the pawl carrying members within the ratchet wheel **19**. Repeated energization and de-energization of the coil **38**, as by the application of electrical pulses to it, will cause repeated attraction and release of the armature **42** which is shown in its attracted position. This action will in turn produce the required reciprocation of the actuating member **32** and thereby turn the ratchet wheel **19** in the manner already described.

What I claim is:

1. A multi-position rotary switch comprising a central rotary spindle, at least one bank of magnetically actuatable reed contact switching units disposed at angularly spaced switching position around the spindle in a circular array, a permanent magnet switching assembly mounted on the spindle for rotation therewith and providing at a position radially offset from the spindle a magnetic field which can be brought by said rotation into actuating relationship with each contact unit in turn, thereby to effect sequential switching thereof, and a stepping mechanism for said switch comprising an internally toothed ratchet wheel drivingly coupled to said spindle, a reciprocable actuating member, two further members mounted for angular oscillation about the ratchet wheel axis and coupled to said actuating member for angular displacement in opposite rotational directions on each stroke of the actuating member in one sense and for reverse angular displacements on each stroke of the actuating member in the opposite sense, and two pawls respectively carried by said two further members and co-operating with said ratchet wheel at substantially diametrically opposed locations, said pawls acting alternately in driving the ratchet wheel on reciprocation of said actuating member.

2. A multi-position rotary switch comprising a rotary spindle, a plurality of contact means disposed at angularly spaced switching positions around the spindle, rotatable switching means mounted on the spindle and rotatable therewith for effecting switching through said contact means at each of said switching positions in turn, and a stepping mechanism which comprises an internally toothed ratchet wheel drivingly coupled to said spindle, two pawls acting in the same rotational sense on the wheel at substantially diametrically opposed positions thereon, respective angularly oscillatable members carrysaid pawls and a reciprocable actuating member coupled with the pawl carrying members for causing angular movements of the pawl carrying members in opposite rotational directions on each stroke of the actuating member in one sense so that one pawl drivingly engages the ratchet wheel, and for causing reverse angular movements of these members on each stroke in the opposite sense so that the other pawl drivingly engages the ratchet wheel, the two pawls thus acting alternately in driving the ratchet wheel and the switching means stepwise in one and the same rotational direction.

3. A multi-position rotary switch comprising a central rotary spindle, at least one bank of magnetically actuatable reed contact switching units disposed at angularly spaced switching positions around the spindle in a circular array, a permanent magnet switching assembly mounted on the spindle for rotation therewith and providing at a position radially offset from the spindle a magnetic field which can be brought by said rotation into actuating relationship with each contact unit in turn, thereby to effect sequential switching thereof, flux controlling side members included in the permanent magnet assembly for limiting the sideways spread of said magnetic field, and a stepping mechanism for said switch comprising an internally toothed ratchet wheel drivingly coupled to said spindle, two pawls acting in the same rotational sense on the wheel at substantially diametrically opposed positions thereon, respective angularly oscillatable members carrying said pawls, and a reciprocable actuating member coupled with the pawl carrying members for causing angular movements of the pawl carrying mem-

bers in opposite rotational directions on each stroke of the actuating member in one sense so that one pawl drivingly engages the ratchet wheel, and for causing reverse angular movements of these members on each stroke in the opposite sense so that the other pawl drivingly engages the ratchet wheel, the two pawls thus acting alternately in driving the ratchet wheel and the switching means stepwise in one and the same rotational direction.

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